MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2022/2023

PPP0101 PRINCIPLES OF PHYSICS

(Foundation in Information Technology)

7 OCTOBER 2023
9:00 A.M. – 11:00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 6 pages, excluding the cover page.
2. Answer all questions.
3. Write your answers on the answer booklet provided.
4. Show all relevant steps to obtain maximum marks.

QUESTION 1 (10 MARKS)

a) Using your own words or simple illustration, define the following terms:

i) Free body diagram [1 mark]

ii) Normal force [1 mark]

iii) Frictional force [1 mark]

iv) Newton second law [1 mark]

b) A force of 50.0 N is required to start a 10.0 kg box moving across a horizontal concrete floor.

i) Sketch free body diagram for this system.

[2 marks]

ii) What is the coefficient of static friction between the box and the floor?

[2 marks]

iii) If the 50.0 N force continues, the box accelerates at 0.80 m/s^2. What is the coefficient of kinetic friction?

[2 marks]

QUESTION 2 (10 MARKS)

a) Sketch a diagram to illustrate how to measure amplitude and period for a mass-spring system. Label accordingly.

[2 marks]

b) In a horizontal mass-spring system, the 1.0 kg mass vibrates according to the equation $x = 0.6cos(10.4t)$, where x is in meters, and t is in seconds. Determine the

i) amplitude. [1 mark]

ii) frequency. [1 mark]

iii) total energy. [Hint : first step, obtain the spring constant, k]

[2 marks]

iv) kinetic energy and potential energy when x is 0.30 m.
[Hint: determine the speed at $x = 0.3\ m$, then convert to KE.
Use $E_T = KE + PE$ to get PE]

[3 marks]

v) equation of velocity at any instant of time.

[1 mark]

Continued...

QUESTION 3 (15 MARKS)

a) Provide the difference between mechanical waves and electromagnetic waves. Give one example for each type of wave.

[4 marks]

b) Sketch transverse wave and logitudinal wave. Give one example for each type of wave.

[4 marks]

c) Determine the speed and direction of propagation of the following sinusoidal wave, assuming that x is measured in meters and t is in seconds.

$$y(x,t) = 6.0 \cos(6.0x - 6.0t)$$

[2 marks]

d) Two waves on a rope are given by

$$y(x,t) = (0.45cm)\sin[\pi(0.30x + 100t)]$$
$$y(x,t) = (0.45cm)\sin[\pi(0.30x - 100t)]$$

The two waves are superposed, producing a standing wave.

i) Find the equation of the standing wave.

[1 mark]

ii) Find the positions of nodes of this standing wave.

[2 marks]

e) Calculate the sound level in dB of a sound wave that has an intensity of 4.0 $\mu W/m^2$.

[1 mark]

f) A train is moving parallel to a highway at 20 m/s. A car is travelling in the same direction as the train at 40 m/s. The car horn sounds at 510 Hz and the train whistle sounds at 320 Hz . When the car is behind the train what frequency does an occupant of the car observe for the train whistle? Use speed of sound in air as 340 m/s.

[1 mark]

Continued...

QUESTION 4 (15 MARKS)

a) Define the following terms. You can use diagram as an aid.

i) Law of reflection. [1 mark]

ii) Snell's law [1 mark]

iii) Total internal reflection [1 mark]

iv) Constructive interference [1 mark]

v) Diffraction [1 mark]

b) A two-slit experiment with slits separated by 50.0×10^{-5} m produces a second-order maximum at angle of $0.10°$.

i) Find the wavelength of the light used in this experiment. [1 mark]

ii) If the slit separation is increased, but the second–order maximum stays at the same angle, does the wavelength increase, decrease, or stay the same? Explain. [1 mark]

c) A beam of light is passing through air to oil to water.

i) If the angle of incidence in the air is 40°, find the angle of refraction in the water. The index of refraction for the oil is 1.45. [1 mark]

ii) If possible, find the angle of incidence in air such that the beam will not enter the water. [1 mark]

iii) Suppose that the direction of the beam is reversed. If possible, find the critical angle of incidence in water so that the beam will not enter the air. [1 mark]

d) State two conditions for total internal reflection to occur.

[2 marks]

e) A narrow beam of monochromatic light of wavelength 590 nm is directed normally at a diffraction grating. The grating spacing is 1.67×10^{-6} m. Determine the highest order of the interference pattern that can be observed at this wavelength.

[3 marks]

End of questions.

APPENDIXES

LIST OF PHYSICAL CONSTANTS

Electron mass,	m_e	=	9.11×10^{-31} kg
Proton mass,	m_p	=	1.67×10^{-27} kg
Neutron mass,	m_n	=	1.67×10^{-27} kg
Magnitude of the electron charge,	e	=	1.602×10^{-19} C
Universal gravitational constant,	G	=	6.67×10^{-11} N.m^2 kg^{-2}
Universal gas constant,	R	=	8.314 J/K.mol
Hydrogen ground state,	E_o	=	13.6 eV
Boltzmann's constant,	k_B	=	1.38×10^{-23} J/K
Compton wavelength,	λ_χ	=	2.426×10^{-12} m
Planck's constant,	h	=	6.63×10^{-34} J.s
		=	4.14×10^{-15} eV.s
Speed of light in vacuum,	c	=	3.0×10^8 m/s
Rydberg constant,	R_H	=	1.097×10^7 m^{-1}
Acceleration due to gravity,	g	=	9.81 m s^{-2}
1unified atomic mass unit,	1 u	=	931.5 MeV/c^2
		=	1.66×10^{-27} kg
1 electron volt,	1 eV	=	1.60×10^{-19} J
Avogadro's number,	N_A	=	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing,	I_o	=	1.0×10^{-12} W m^{-2}
Coulomb constant,	$k = \frac{1}{4\pi\varepsilon_o}$	=	9.0×10^9 Nm^2 C^{-2}
Permittivity of free space,	ε_o	=	8.85×10^{-12} C^2/N.m^{-2}
Permeability of free space,	μ_o	=	$4\pi \times 10^{-7}$ (T.m)/A
1 atmosphere pressure,	1 atm	=	1.0×10^5 N/m^2
			1.0×10^5 Pa
Earth: Mass,	M_E	=	5.97×10^{24} kg
Radius (mean),	R_E	=	6.38×10^3 km
Moon: Mass,	M_M	=	7.35×10^{22} kg
Radius (mean),	R_M	=	1.74×10^3 km
Sun: Mass,	M_S	=	1.99×10^{30} kg
Radius (mean),	R_S	=	6.96×10^5 km
Earth-Sun distance (mean),		=	149.6×10^6 km
Earth-Moon distance (mean),		=	384×10^3 km

Continued...

LIST OF FORMULA

Differential Rule

$$y = kx^n$$

$$\frac{dy}{dx} = knx^{n-1}$$

Trigonometric Identity

$$\sin\theta = \frac{opposite}{hypotenuse} \qquad \cos\theta = \frac{adjacent}{hypotenuse}$$

$$\tan\theta = \frac{opposite}{adjacent}$$

$$\sin\alpha + \sin\beta = 2\cos\left(\frac{\alpha-\beta}{2}\right)\sin\left(\frac{\alpha+\beta}{2}\right)$$

$$\sin(\alpha-\beta) + \sin(\alpha+\beta) = 2\sin\alpha\cos\beta$$

NEWTONIAN MECHANICS

$$v = \frac{\Delta x}{\Delta t} \qquad a = \frac{\Delta v}{\Delta t} \qquad v = v_o + at \qquad x - x_o = v_o t + \frac{1}{2}at^2$$

$$v^2 = v_o^2 + 2a(x - x_o) \qquad x - x_o = \left(\frac{v_o + v}{2}\right)t$$

$$v = v_o + gt \qquad y - y_o = v_o t + \frac{1}{2}gt^2 \qquad v^2 = v_o^2 + 2g(y - y_o) \qquad y - y_o = \left(\frac{v_o + v}{2}\right)t$$

$$W = Fs\cos\theta \qquad W = mg \qquad \sum F = F_{net} = ma \qquad f_s \le \mu_S F_N$$

$$f_k = \mu_K F_N \qquad K = \frac{1}{2}mv^2 \qquad PE_s = \frac{1}{2}kx^2 \qquad F_s = -kx$$

$$PE_G = mgy \qquad T_s = 2\pi\sqrt{\frac{m}{k}}$$

Spring with mass, $\omega = \sqrt{\frac{k}{m}}$ Simple pendulum, $\omega = \sqrt{\frac{g}{l}}$ $T_p = 2\pi\sqrt{\frac{l}{g}}$ $T = \frac{2\pi}{\omega} = \frac{1}{f}$

Cosine Wave:

$$x = A\cos\omega t$$
$$v = -\omega A\sin\omega t$$
$$a = -\omega^2 A\cos\omega t$$

Sine Wave:

$$x = A\sin\omega t$$
$$v = \omega A\cos\omega t$$
$$a = -\omega^2 A\sin\omega t$$

WAVES AND OPTICS

$$v = f\lambda \qquad \omega = 2\pi f \qquad n = \frac{c}{v} \qquad n_1\sin\theta_1 = n_2\sin\theta_2$$

$$\sin\theta_c = \frac{n_2}{n_1} \qquad \frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} \qquad M = -\frac{d_i}{d_o} = \frac{h_i}{h_o} \qquad f = \frac{R}{2}$$

$$d\sin\theta_{max} = m\lambda \qquad d\sin\theta_{min} = (m + \frac{1}{2})\lambda$$

$$y_{bright} = \frac{m\lambda L}{d} \qquad y_{dark} = (m + \frac{1}{2})\frac{\lambda L}{d} \qquad I = \frac{P}{A} \qquad \beta = 10\log_{10}\frac{I}{I_o}$$

Continued...

$$f' = f\left(\frac{v \pm v_o}{v \mp v_s}\right) \qquad y(x,t) = A\sin(kx \pm \omega t + \phi)$$

Wave Type:

$$y(x,t) = 2A\cos\left(\frac{\phi}{2}\right)\sin(kx - \omega t - \frac{\phi}{2})$$

$$y(x,t) = 2A\sin\ kx\ \cos\omega t$$

End of page